



INTERRELATIONSHIP PERFORMANCE INDICATORS MODEL OF SUSTAINABLE PROCUREMENT IN HIGHER EDUCATION

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ABSTRACT

Sustainable procurement is developing among practitioners and academics, but not many have done this research with the object of higher education institutions. This study succeeded in obtaining twelve indicators of sustainable procurement in higher education in Indonesia. The interpretive structural modeling method is used to model these indicators so that a four-level model is obtained, where the first level consists of seven indicators, the second level is one indicator, the third level is two indicators, and the fourth level is two indicators. In addition, the twelve indicators were also grouped using MICMAC analysis into four quadrants. Eight indicators are included in the autonomous indicators' quadrant, four indicators are included in the independent indicators' quadrant. Nothing is included in the dependent indicators and linkage indicators quadrant. This study proposes to the management of higher education to improve the performance of sustainable procurement, starting from level four indicators, namely the existence of routine monitoring and sustainability criteria (P12) and there is awareness of sustainable procurement on campus internals (P2).

INTRODUCTION

Sustainable procurement is currently being developed among practitioners and academics. The development of sustainable procurement coincides with the efforts to achieve sustainable development proclaimed by the United Nations . The development of sustainable procurement also coincides with the development of other terms in related academic publications such as green supply, green purchasing, environmental supplier performance, green supply chain management, green value chain, green supply chain, environmental supply chain management, environmental purchasing, green purchasing and supply policies (Walker & Phillips, 2009). It can be said that sustainable procurement related with activity to buy product or service that minimize impact to environment and also get positive outcomes to economy, society and environment itself (McLeod et al., 2015)

The sustainable development that is proclaimed by the United Nations, one of which can specifically implement it through sustainable procurement, should be pursued by every

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organization, including higher education institutions. Higher education includes faculties, departments, staff, and students will give a big impact on society when they apply sustainable consumption because it's involving many parties. According to Pacheco-Blanco & Bastante-Ceca (2016) that discussed university's contribution to sustainable consumption through Green Public Procurement Initiative, Spanish universities generally provide specific environmental criteria in their procurement contract to increase organizational awareness. Leal Filho et al. (2019) survey Higher Education Institution (HEI) around the world about their role in terms of the drivers and challenges factors and how far they support sustainable procurement practices. They found unidentified enablers and barriers, then gave recommendations to smaller HEI for applying sustainable procurement policy as soon as possible.

Muria Kudus University as the largest Higher Education Institution in the eastern north sea of Central Java has declared itself a Green Campus as evidenced by the establishment of the Unit for Occupational Health, Safety and Environment (K3L) in 2019. K3L Unit only focuses on building and environmental maintenance, for example: the purchase of handwash soap and hand sanitizer does not take into environmental aspects. Campus staffs who have procurement responsibilities have less awareness regarding the environment aspects, there is no collaboration with K3L, so they work independently. It can be concluded that sustainable procurement has not yet reached its implementation in Muria Kudus University environment, as well as performance measurement.

This research will identify indicators of sustainable procurement in higher education institutions, where these indicators are then modeled using the interpretative structural modeling (ISM) method to determine the relationship between indicators and the level of each indicator. Then each indicator is also classified into four clusters. All of these things are done so that higher education institutions can properly design strategies for implementing sustainable procurement.

RESEARCH METHOD

In general, this research method starts with the identification of sustainable procurement performance indicators for Higher Education, then continues by developing a contextual relationship (X) between sustainable performance indicators for Higher Education. Contextual relationships with the help of these experts produce a structural-self interaction matrix (SSIM). After SSIM is structured, it is followed by compiling the initial reachability matrix and the final reachability matrix. The final reachability matrix is then used as the basis for drafting the digraph and draft of the ISM model. The ISM model that is formed is then validated, if it is consistent, the model is considered valid and can represent the interrelationship performance indicators of the model of sustainable procurement in higher education. Finally, after the ISM model is formed, a driving power-dependence diagram is compiled. The complete stages of this research are shown in Figure 1.

A. Identify Sustainable Procurement Performance Indicators for Higher Education

In the early stages of this research, the identification of sustainable procurement performance indicators for higher education was carried out through a process of content analysis of some papers related to sustainable procurement. Content analysis is done by filtering words or sentences to be simpler than a text (Primadasa & Tauhida, 2020) or it could be by making it easier to understand. The results of this stage can be seen in Table 1.

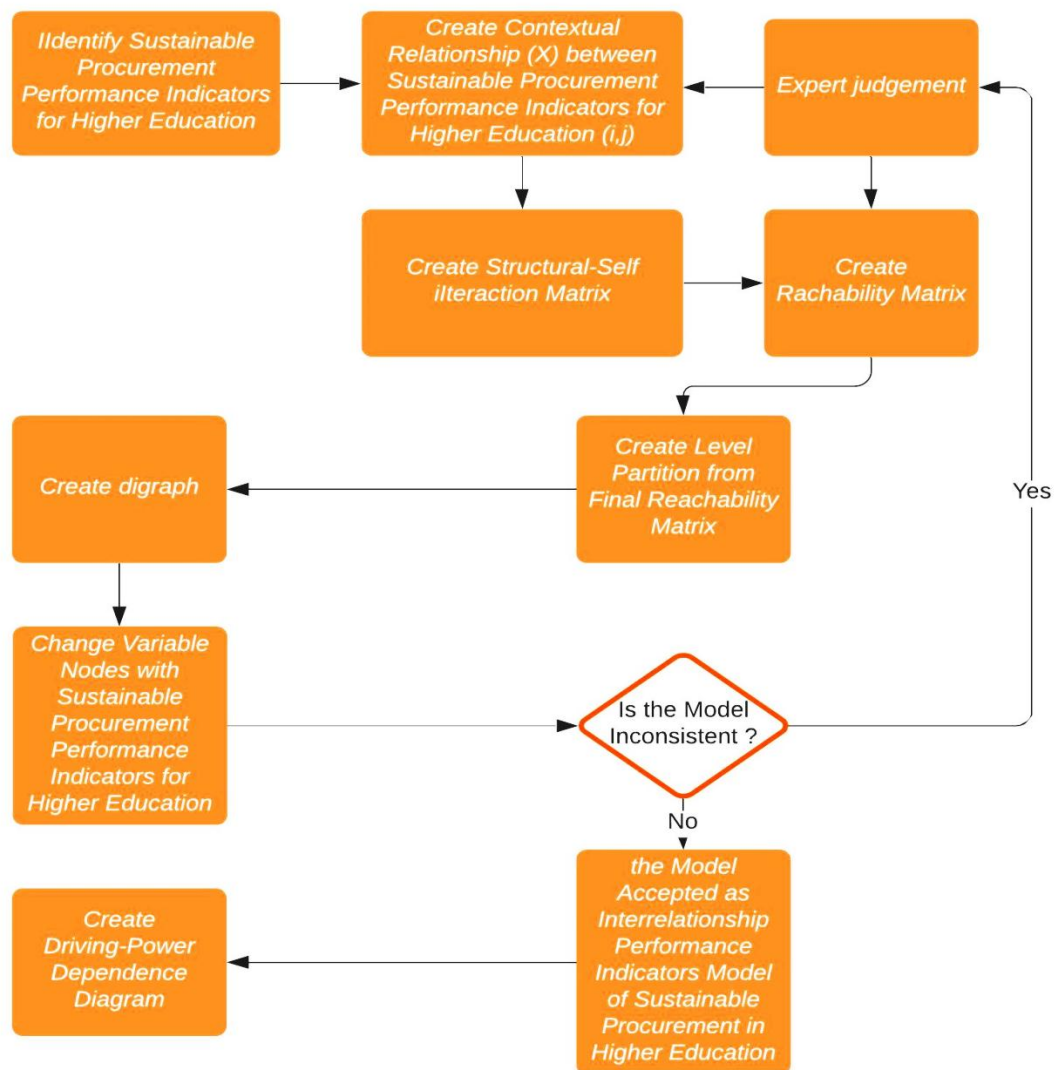


Figure 1. Research Method Flowchart

B. Create Structural Self Interaction Matrix (SSIM)

The sustainable procurement indicators for Higher Education indicators that have been obtained are used as the basis for conducting the process of creating contextual relationships between indicators by expert judgment. In this case, officials on campus are responsible for the procurement process. This expert judgment is then presented in the form of a structural self interaction matrix (SSIM). The contextual relationship rules in SSIM are written with code V, A, X, O where if V is written then indicator i will affect indicator j , if it is written A then indicator j will affect indicator i , if it is written X then indicator i and j affect one another each other. Finally, if it is written O then the indicators i and j do not affect each other (Soni & Kodali, 2016).

Table 1. Sustainable procurement Indicators for Higher Education

No	Code	Sustainable Procurement Performance Indicators for Higher Education	References
1	P1	The existence of policies and regulations regarding sustainable procurement	(Leal Filho et al., 2019)
2	P2	There is awareness of sustainable procurement on campus internals	(Leal Filho et al., 2019)
3	P3	Assessment of suppliers with sustainability criteria	(Grob & Benn, 2014)
4	P4	Indoor lighting choose energy-efficient lighting products	(Pacheco-Blanco & Bastante-Ceca, 2016)
5	P5	Food purchases and catering choose wrappers that are not disposable or choose easily biodegradable wrappers	(Pacheco-Blanco & Bastante-Ceca, 2016)
6	P6	Purchase a campus vehicle that is low in emissions	(Pacheco-Blanco & Bastante-Ceca, 2016)
7	P7	Purchasing paper chooses products from companies that do not have a reputation for illegal logging	(Pacheco-Blanco & Bastante-Ceca, 2016)
8	P8	Purchasing information technology equipment that saves electricity	(Pacheco-Blanco & Bastante-Ceca, 2016)
9	P9	Building materials for the renovation of campus buildings are chosen which are environmentally friendly	(Pacheco-Blanco & Bastante-Ceca, 2016)
10	P10	Selection of environmentally friendly furniture products	(Pacheco-Blanco & Bastante-Ceca, 2016)
11	P11	Sustainable procurement awareness raising program on campus	(Leal Filho et al., 2019)
12	P12	The existence of routine monitoring and sustainability criteria	(Leal Filho et al., 2019)

Table 3. Rules to substitute of SSIM into initial Reachability Matrix

Code in Cell ij SSIM	Value in Cell ij Initial Reachability Matrix	Value in Cell ji Initial Reachability Matrix
V	1	0
A	0	1
X	1	1
O	0	0

Table 2. Structural Self Interaction Matrix (SSIM) sustainable procurement for Higher Education

Code	P12	P11	P10	P9	P8	P7	P6	P5	P4	P3	P2
P1	X	V	V	V	V	V	V	V	V	V	A
P2	X	X	V	V	V	V	V	V	V	V	
P3	O	O	O	O	O	O	O	O	O		
P4	O	O	O	O	V	O	O	O			
P5	O	A	O	O	O	O	O				
P6	A	A	O	O	O	O					
P7	A	A	O	O	O						
P8	A	A	O	O							
P9	A	A	O								
P10	A	A									
P11	V										

C. Create Reachability Matrix

After the SSIM Matrix is compiled with codes V, A, X, O, the process of creating the initial reachability matrix is carried out by converting it into binary codes, namely 1 and 0 depending on the relationship, the rules is shown in Table 3 (Kota et al., n.d.). After the initial reachability matrix is arranged as shown in Table 3, the next step is to compile the final reachability matrix using the transitivity principle, where cells in the initial reachability matrix are used as a reference. If variable *i* is related to variable *j* and variable *j* is related to variable *k*, then variable *i* should be related to variable *k* (Jadhav et al., 2014).

Table 4. Initial Reachability Matrix

Code	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
P1	1	0	1	1	1	1	1	1	1	1	1	0
P2	1	1	1	1	1	1	1	1	1	1	1	1
P3	0	0	1	0	0	0	0	0	0	0	0	0
P4	0	0	0	1	0	0	0	1	0	0	0	0
P5	0	0	0	0	1	0	0	0	0	0	0	0
P6	0	0	0	0	0	1	0	0	0	0	0	0
P7	0	0	0	0	0	0	1	0	0	0	0	0
P8	0	0	0	0	0	0	0	1	0	0	0	0
P9	0	0	0	0	0	0	0	0	1	0	0	0
P10	0	0	0	0	0	0	0	0	0	1	0	0
P11	0	1	0	0	1	1	1	1	1	1	1	1
P12	1	1	0	0	0	1	1	1	1	1	0	1

Table 5. Final Reachability Matrix

Code	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	Driving Power
P1	1	0	1	1	1	1	1	1	1	1	1	0	10
P2	1	1	1	1	1	1	1	1	1	1	1	1	12
P3	0	0	1	0	0	0	0	0	0	0	0	0	1
P4	0	0	0	1	0	0	0	1	0	0	0	0	2
P5	0	0	0	0	1	0	0	0	0	0	0	0	1
P6	0	0	0	0	0	1	0	0	0	0	0	0	1
P7	0	0	0	0	0	0	1	0	0	0	0	0	1
P8	0	0	0	0	0	0	0	1	0	0	0	0	1
P9	0	0	0	0	0	0	0	0	1	0	0	0	1
P10	0	0	0	0	0	0	0	0	0	1	0	0	1
P11	1	1	1	1	1	1	1	1	1	1	1	1	12
P12	1	1	1	1	1	1	1	1	1	1	1	1	12
Dependence Power	4	3	5	5	5	5	5	6	5	5	4	3	

D. Create Level Partitions

After the final reachability matrix is arranged, level partitions are carried out. There are 3 main columns in the partitions level, namely reachability set, antecedent set, and intersection set. The reachability set consists of the variable itself and the variables that affect it, while the antecedent set consists of the variable itself and other affected variables, the intersection set is a slice between the reachability set and the antecedent set (Singhal et al., 2018).

Table 6. Level partitions iteration 1

Code	Reachability Set	Antecedent Set	Intersection Set	Level
P1	1,3,4,5,6,7,8,9,10,11	1,2,11,12	1,11	
P2	1,2,3,4,5,6,7,8,9,10,11,12	2,11,12	2,11,12	
P3	3	1,2,3,11,12	3	1
P4	4,8	1,2,4,11,12	4	
P5	5	1,2,5,11,12	5	1
P6	6	1,2,6,11,12	6	1
P7	7	1,2,7,11,12	7	1
P8	8	1,2,4,8,11,12	8	1
P9	9	1,2,9,11,12	9	1
P10	10	1,2,10,11,12	10	1
P11	1,2,3,4,5,6,7,8,9,10,11,12	1,2,11,12	1,2,11,12	
P12	1,2,3,4,5,6,7,8,9,10,11,12	2,11,12	2,11,12	

Table 7. Level partitions iteration 2

Code	Reachability Set	Antecedent Set	Intersection Set	Level
P1	1,4,11	1,2,11,12	1,11	
P2	1,2,4,11,12	2,11,12	2,11,12	
P4	4	1,4,11,12	4	2
P11	1,2,4,11,12	1,2,11,12	1,2,11,12	
P12	1,2,4,11,12	2,11,12	2,11,12	

Table 8. Level partitions iteration 3

Code	Reachability Set	Antecedent Set	Intersection Set	Level
P1	1,11	1,2,11,12	1,11	3
P2	1,2,11,12	2,11,12	2,11,12	
P11	1,2,11,12	1,2,11,12	1,2,11,12	3
P12	1,2,11,12	2,11,12	2,11,12	

Table 9. Level partitions iteration 4

Code	Reachability Set	Antecedent Set	Intersection Set	Level
P2	2,12	2,12	2,12	4
P12	2,12	2,12	2,12	4

E. Create Digraph

After the iteration process at the level partitions is complete, then digraphs are arranged according to the level of the partitions level process. Each variable is symbolized by the variable nodes according to the variable code and the arrow relationship in the direction of influence from variable *i* to *j* (Raut et al., 2018). The result of the final digraph could be seen in Figure 2.

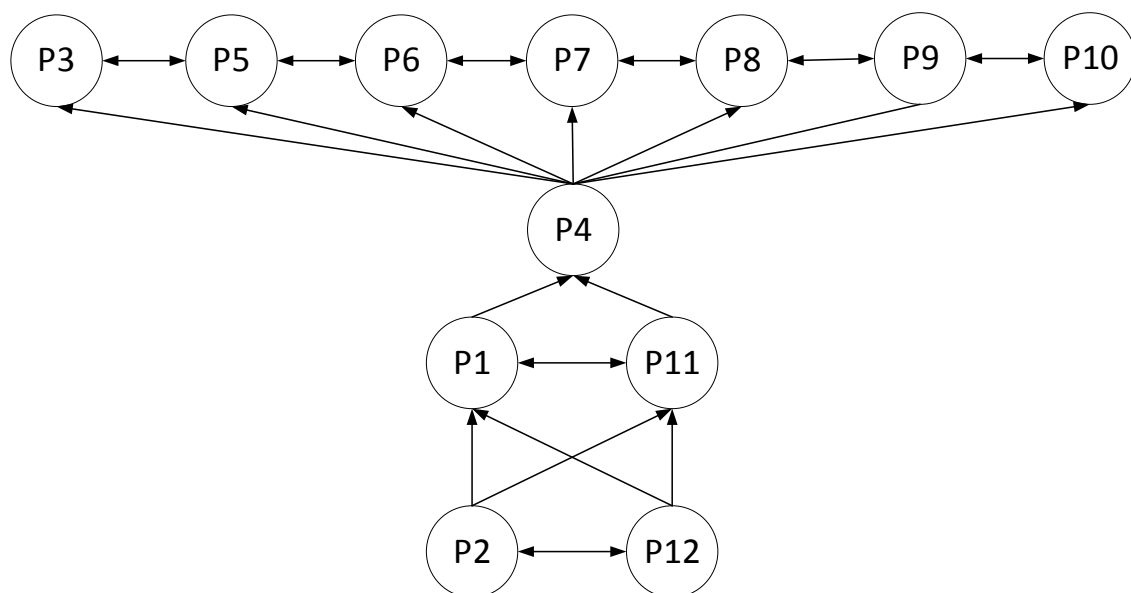


Figure 2. Digraph for interrelationship of sustainable procurement indicators in Higher Education

RESULTS AND DISCUSSION

A. ISM Model

The Digraph that has been compiled is then replaced with an indicator of sustainable procurement for Higher Education (Primadasa et al., 2019). The results of the ISM model that are formed are shown in Figure 3.

The sustainable procurement indicators for Higher Education that are compiled in the ISM model are different from previous research that examined sustainable procurement in Australia and UK Universities (Young et al., 2016). In previous research, each indicator of sustainable procurement was grouped into the categories of drivers, practices, and priorities, while in this study the indicators were arranged in general. This is what makes the indicators arranged differently.

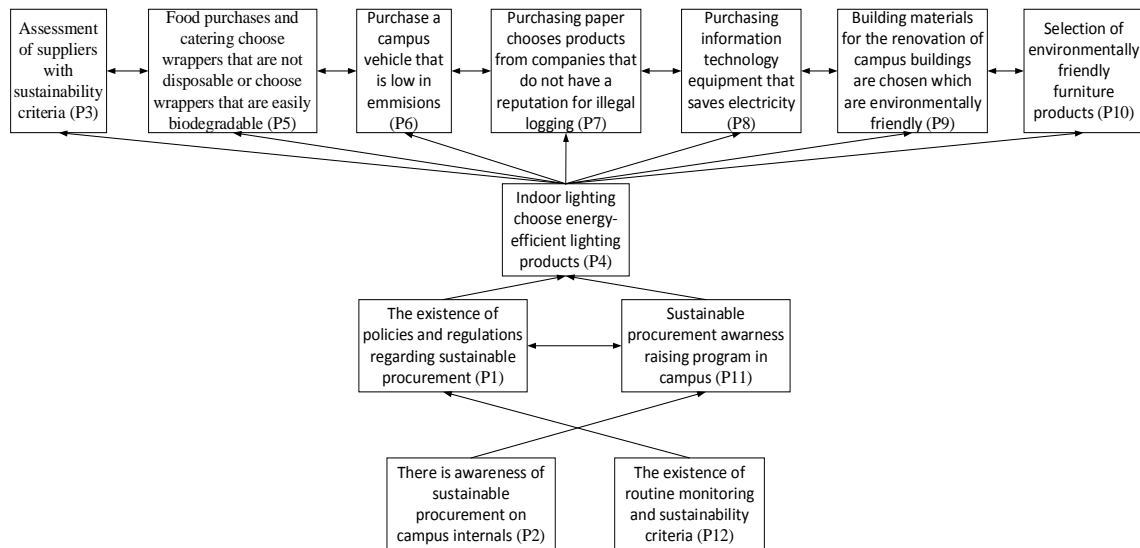


Figure 3. Interpretative structural model of sustainable procurement indicators for Higher Education

The ISM model of sustainable procurement indicators for Higher Education is structured into four levels where the first level consists of seven indicators including assessment of suppliers with sustainability criteria (P3), food purchases and catering wrappers that are not disposable or choose wrappers that are easily biodegradable (P5), purchase campus vehicle that is low emission (P6), purchasing paper chooses products from companies that do not have a reputation for illegal logging (P7), purchasing information technology equipment that saves electricity (P8), building materials for the renovation of campus building are chosen which are environmentally friendly (P9), selection of environmentally friendly furniture product (P10). Only one indicator is at level two, namely indoor lighting choose energy efficient products (P4). In level three there are two indicators including the existence of policies and regulations regarding sustainable procurement (P1) and sustainable procurement awareness raising program in campus (P11). Lastly, in level four consists of two indicators, namely the existence of routine monitoring and sustainability criteria (P12) and there is awareness of sustainable procurement on campus internals (P2).

B. MICMAC Analysis

Each indicator of sustainable procurement for Higher Education is classified using MICMAC analysis, which is obtained from the driving and dependence power of each indicator (Sindhu et al., 2016). The driving value and dependence power can be seen in the final reachability matrix table 5. In this MICMAC analysis, each indicator is grouped into four clusters, namely autonomous indicators, dependent indicators, linkage indicators, and independent indicators (Phogat & Gupta, 2018). The driving dependence power diagram can be seen in Figure 4.

Autonomous indicators are indicators that have a weak driving and dependence power, usually having a less significant impact on other indicators (Chen et al., 2021). There are eight indicators included in this cluster, among others indoor lighting choose energy-efficient lighting products (P4), assessment of suppliers with sustainability criteria (P3), food purchases and catering choose wrappers that are not disposable or choose easily biodegradable wrappers (P5), purchase a campus vehicle that is low in emissions (P6), purchasing paper chooses products from companies that do not have a reputation for illegal logging (P7), building materials for the renovation of campus buildings are chosen which are environmentally friendly (P9), selection of environmentally friendly furniture products (P10) and purchasing information technology equipment that saves electricity (P8). All these eight indicators must be less important than

other indicators, but Higher education institutions still need to encourage program related on it with little attention.

Driving Power	12			P2, P12	P11								
	11												
	10				P1								
	9			Independent Indicators				Linkage Indicators					
	8												
	7												
	6			Autonomous Indicators				Dependent Indicators					
	5												
	4												
	3												
	2					P4							
	1					P3, P5, P6, P7, P9, P10	P8						
	1	2	3	4	5	6	7	8	9	10	11	12	
Dependence Power													

Figure 4. Graph of driving dependence power of sustainable procurement indicators for Higher Education

Dependence indicators have weak driving power but strong dependence power (Digalwar et al., 2017). Otherwise, linkage indicators have strong dependence and driving power (Jia et al., 2014). There is no indicator of sustainable procurement Indicators for Higher Education in this study that includes both dependence indicators and linkage indicators.

Independent Indicators have strong driving power but weak dependence power (Movahedipur et al., 2017). There are four indicators in this study included in this cluster: the existence of policies and regulations regarding sustainable procurement (P1), sustainable procurement awareness raising program in campus (P11), there is awareness of sustainable procurement on campus internals (P2), the existence of routine monitoring and sustainability criteria (P12). These four indicators must be requiring most attention because of their influence to another indicators. Higher Education Institution should focus to encourage program related to it.

CONCLUSIONS

Through the ISM method identified in this study 12 sustainable procurement in higher education is then arranged into a four-level model that describes the relationship between these indicators. Seven indicators are at the first level, then one indicator is at the second level, while the third and fourth levels each consist of two levels. Each indicator is then divided into four clusters using MICMAC analysis, whereof the 12 indicators, 8 of them are included in the cluster autonomous indicators and the other 4 are included in the cluster independent indicators. There are no indicators that are included in the cluster dependent indicators and linkage indicators.

This research only makes one institution an object of research, namely Universitas Muria Kudus, so it cannot fully describe the sustainable procurement model. Research with a wider object needs to be carried out in future research so that it can provide a much more complete picture of the sustainable procurement model in Higher Education institutions.

Higher education institutions in general and Universitas Muria Kudus in particular, if they want to improve the performance of sustainable procurement, it is necessary to pay attention to the 12 indicators obtained in this study. Meanwhile, the action plan that can be done can be started by improving the two indicators that are at the fourth level first on the ISM model, which is formed as shown in figure 3 namely there is awareness of sustainable procurement on campus internals (P2) and the existence of routine monitoring and sustainability criteria (P12).

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